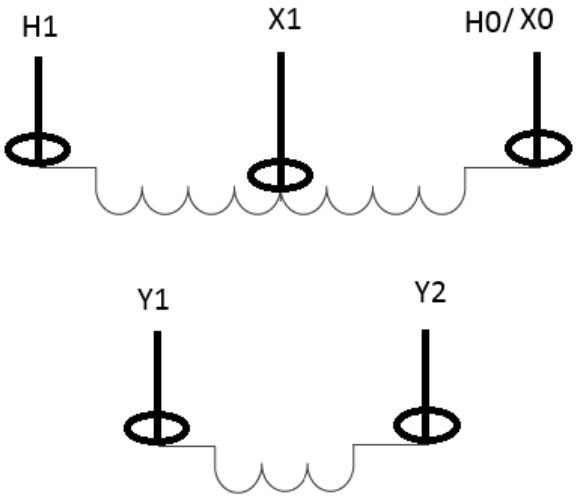
APPLICATION NOTE

Testing bushing CTs in a high noise substation

Objective: This application note demonstrates how to hook up leads and perform the test with MRCT test equipment on bushings CTs of an auto transformer in a high voltage substation with extreme noise and interference.

Test object: Single phase auto transformer



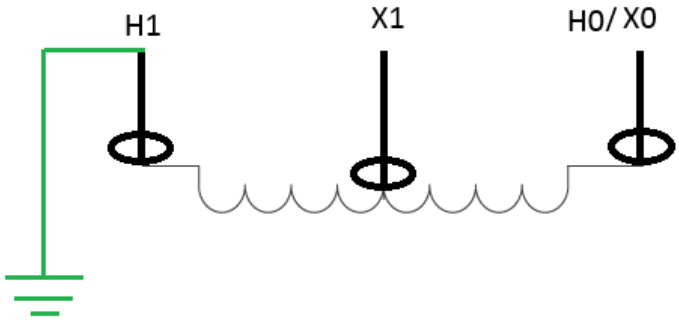
Single phase auto transformer with bushing CTs

Test Equipment: MRCT

H1

Test connections:

Ground the H1 bushing and leave it grounded for the whole duration of testing all CTs as shown below:



Grounding the high side bushing

Grounding is performed to reduce any induced voltage from overhead energized lines

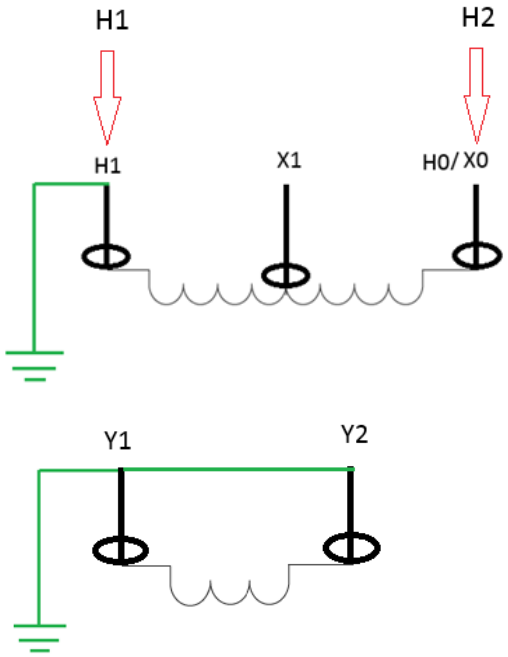
Testing CTs on H side bushing

MRCT unit has H and X test leads

a) Connection of H leads

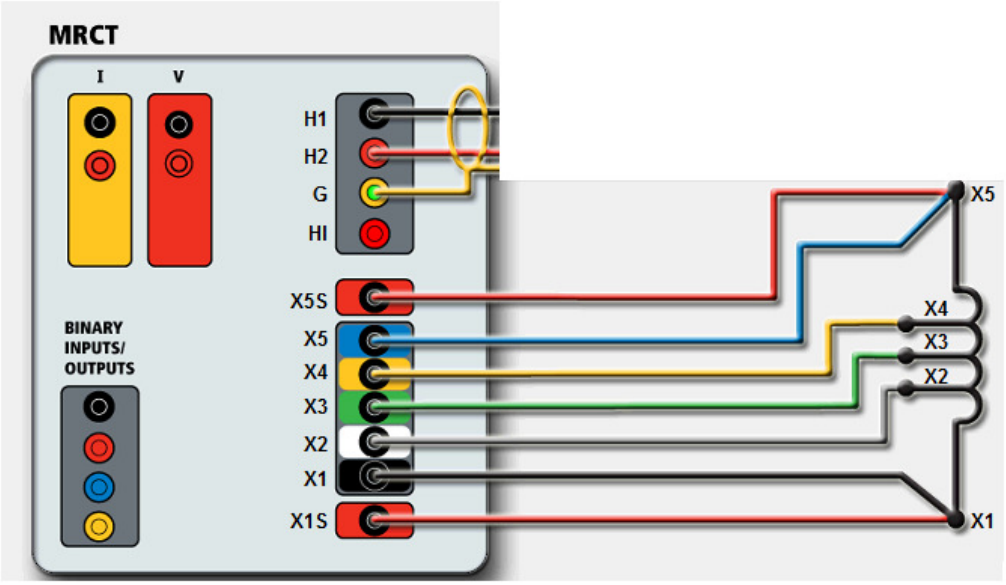
Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0-X0	Y1	Y2
MRCT leads	H1	Floating	H2	Grounded	Grounded



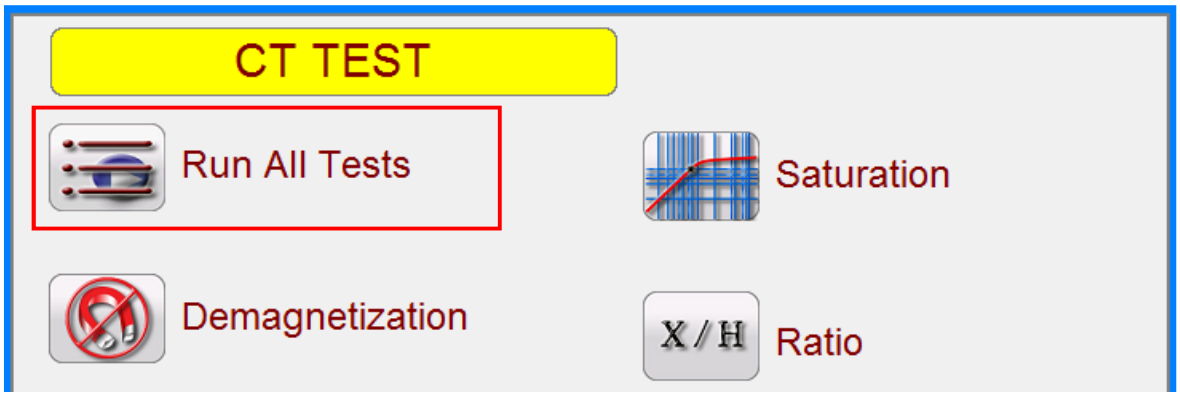
b) Connection of X leads

Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the CT under test as per the diagram shown below.

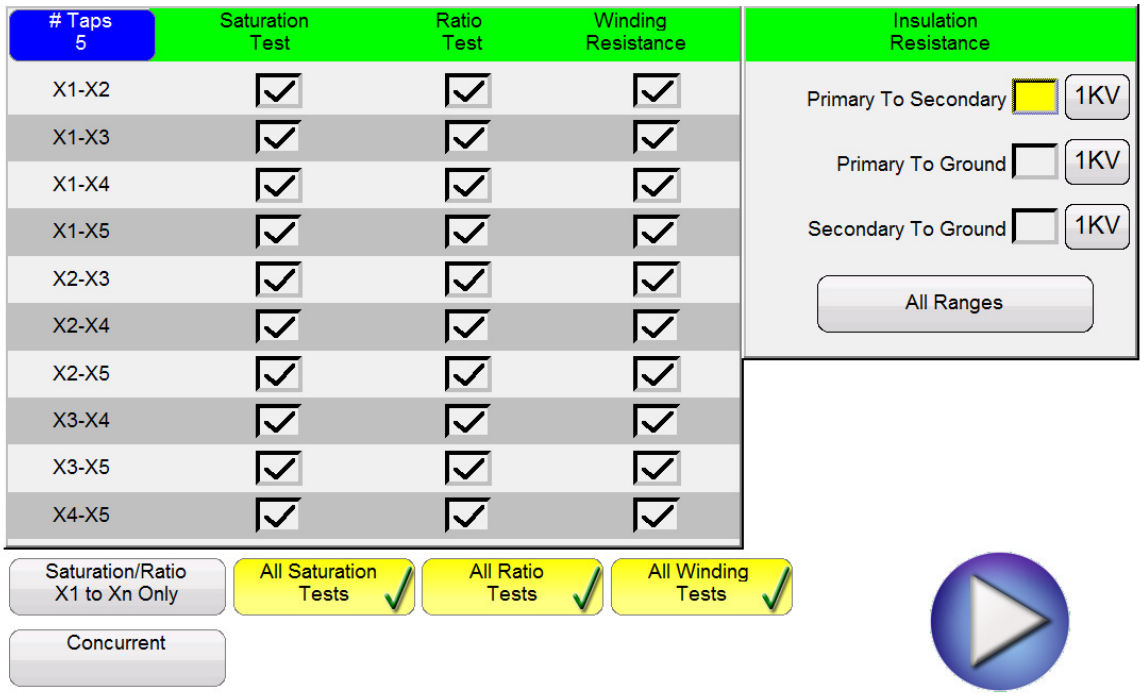


Before proceeding to start the test, please make sure that communication button at the top left side of the software screen is green. This indicates that software is communicating with the test box.

From home screen of the MRCT software select Run All Tests



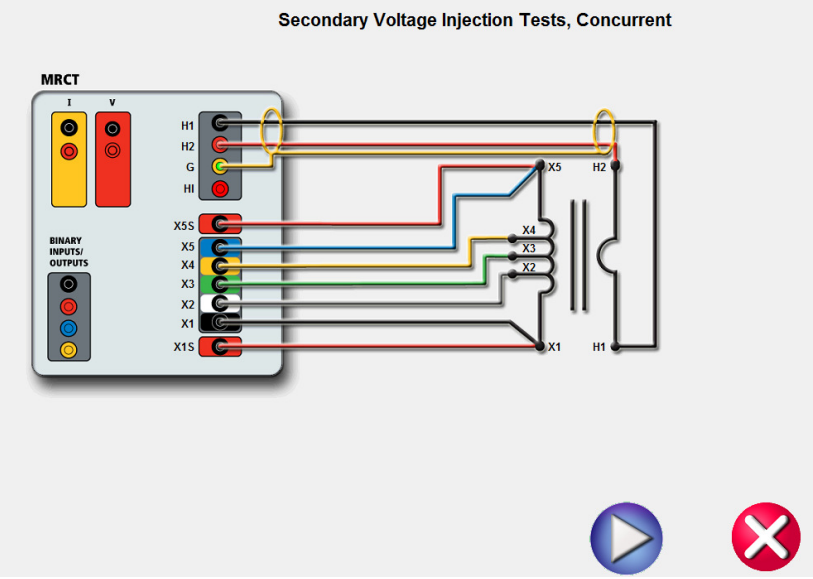
In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:

NAMEPLATE DATA CT: CT1X

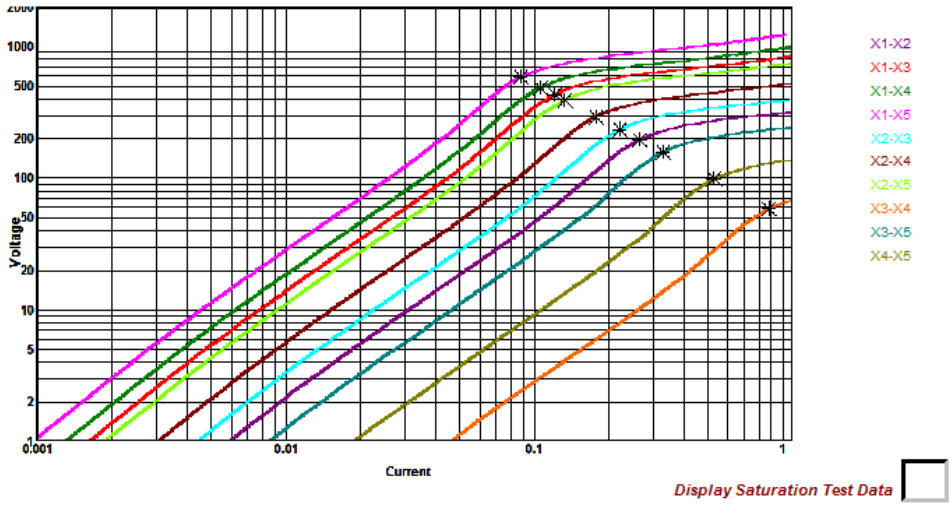
MANUFACTURER SERIAL NO. 5226t3a001 PHASE

ASSET ID ACCURACY CLASS SATURATION STD ANSI 45

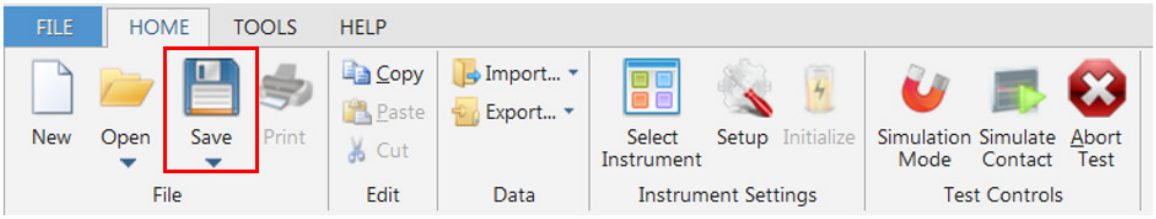
BURDEN VA

Secondary Voltage Injection

	Tap	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
RATIO	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
Phase Dev.		0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
Polarity		Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Knee	Volt.(V)	196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292



Hit the save button to save the file by giving it a file name.

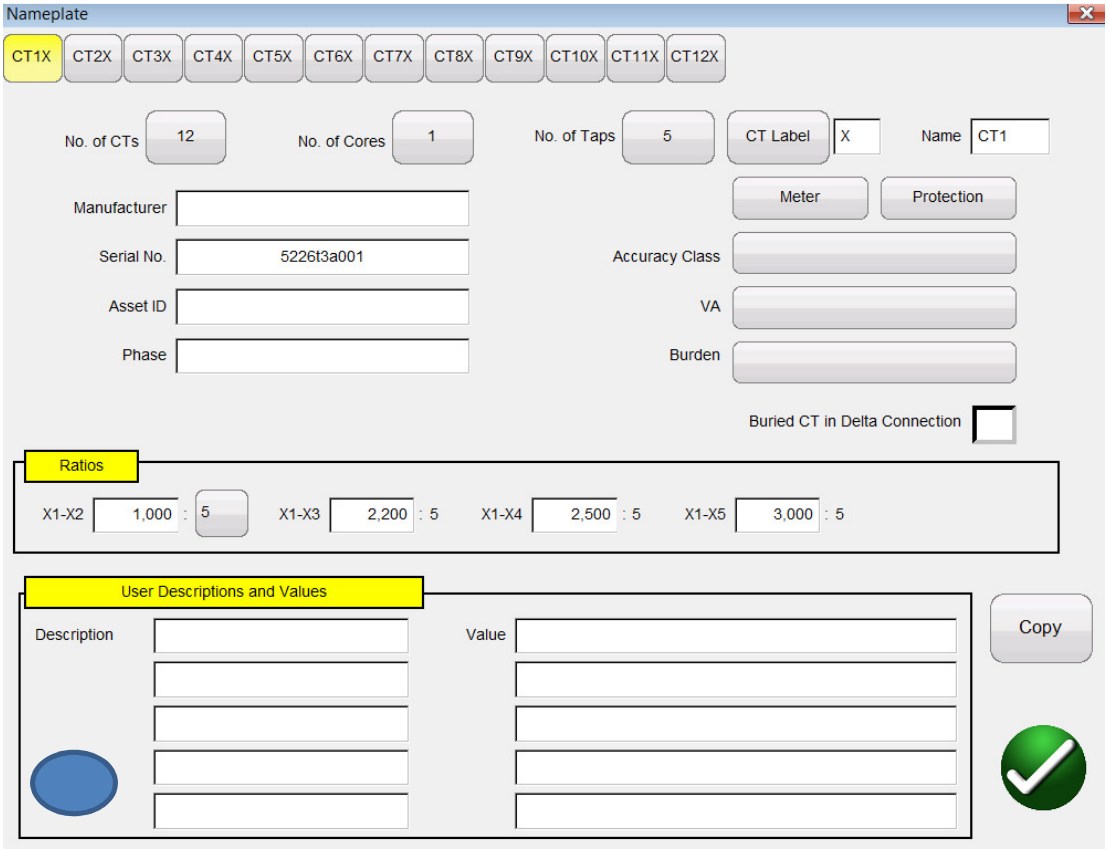


Testing CTs on X1 bushing

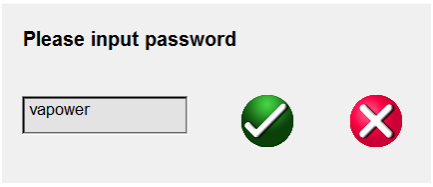
Before testing X1 bushing, follow the below steps to enable a specific setting in MRCT software:

Click on the nameplate icon on the home screen of the software as shown below:

In the nameplate screen, click on the area shown in the blue circle:

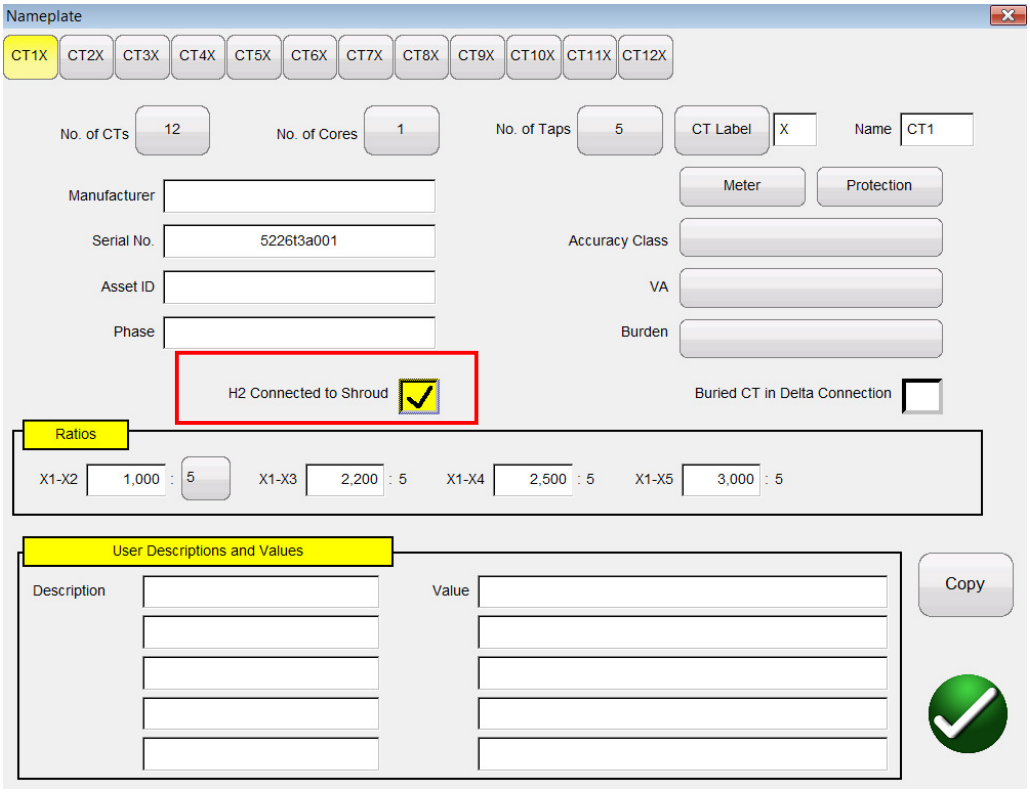


This will pop up a window asking to enter a password. Enter password vapower (case sensitive)

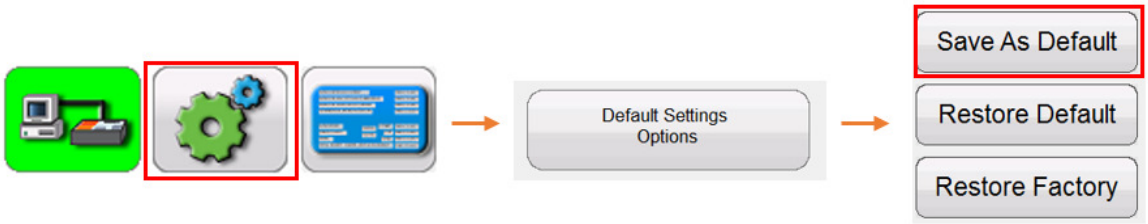


Hit green OK button

This will enable a new selection check box on nameplate screen: “H2 connected to shroud” as shown below:



Please note that user does not have to perform these steps every time. It is performed just one time and can be saved as default settings by following the steps below:

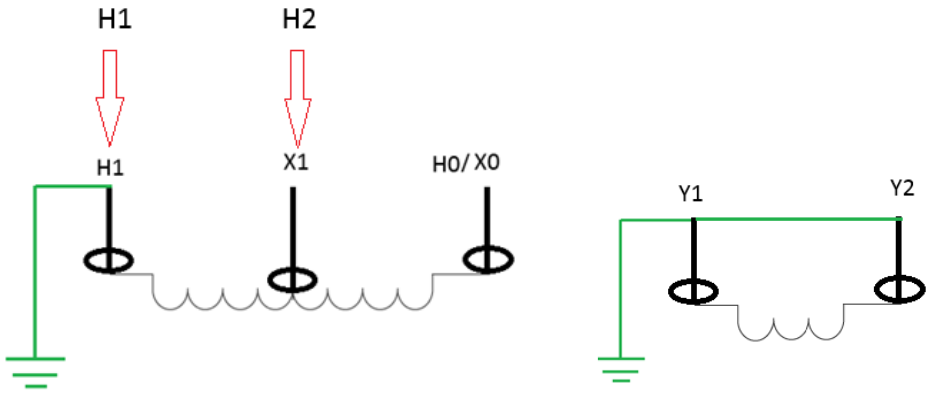


MRCT unit has H and X test leads

a) Connection of H leads

Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	H1	H2	Floating	Grounded	Grounded



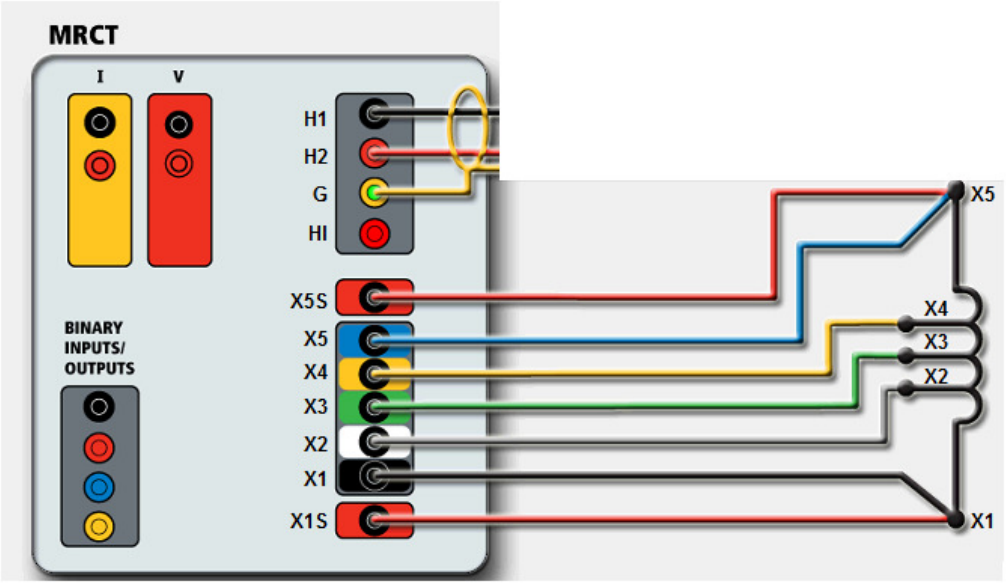
Please note that by connecting H1 and H2 test leads as shown above will generate incorrect polarity but that will be taken care of in section below.

In the nameplate screen check the box “H2 connected to Shroud”

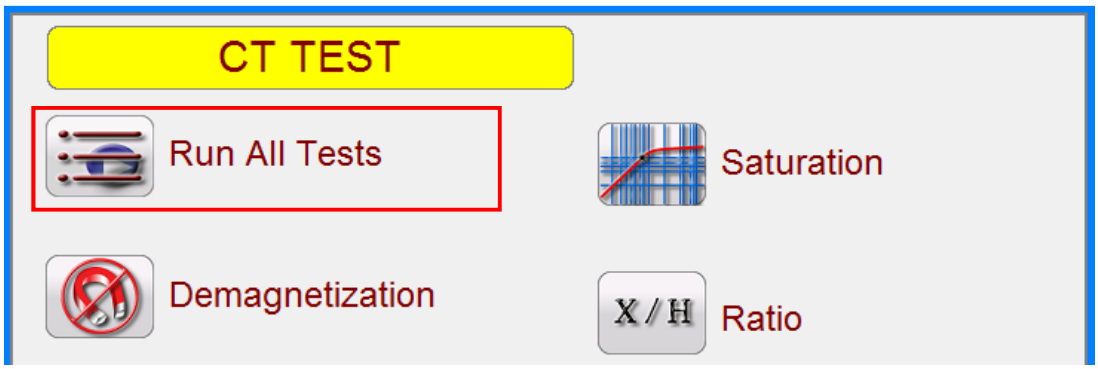
This will take care of incorrect polarity issue.

b) Connection of X leads

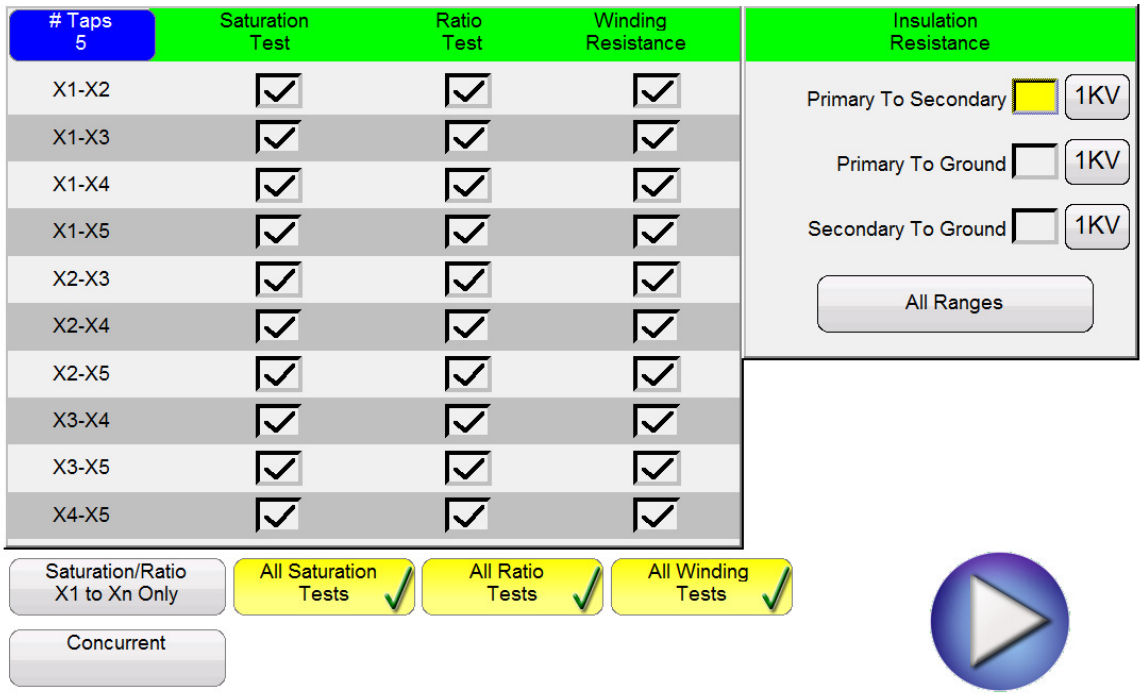
Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the CT under test as per the diagram shown below.



From home screen of the MRCT software select Run All Tests



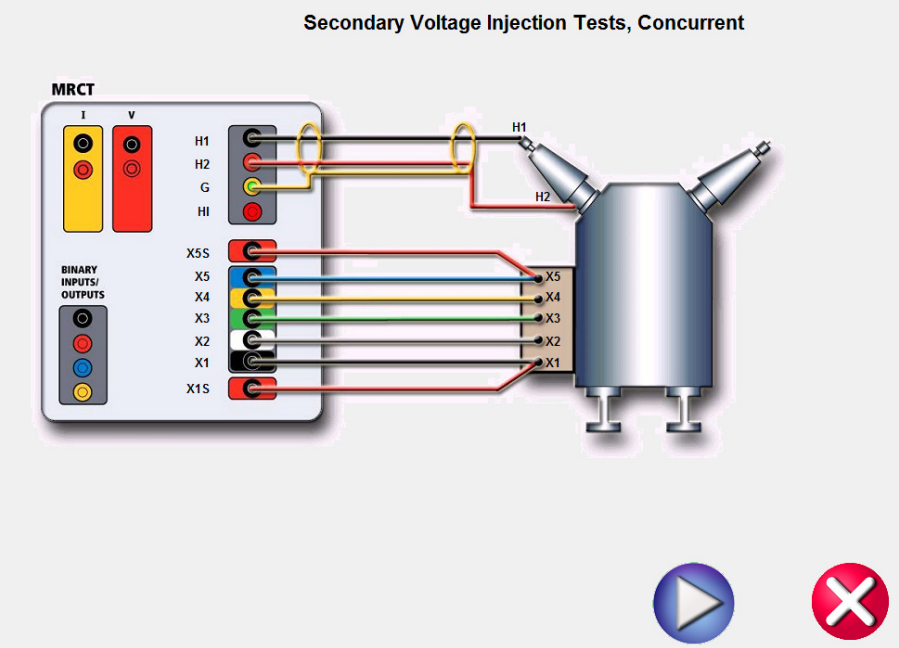
In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:

NAMEPLATE DATA CT: CT1X

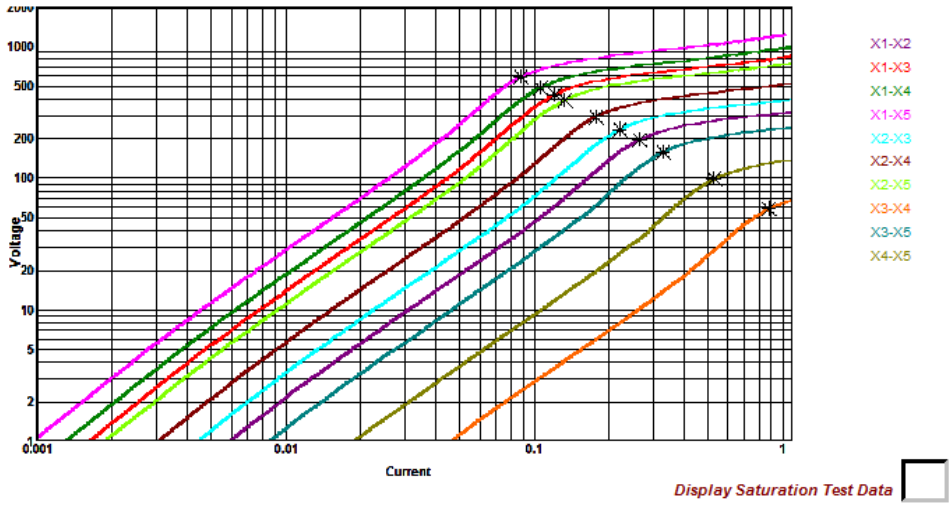
MANUFACTURER SERIAL NO. 5226t3a001 PHASE

ASSET ID ACCURACY CLASS SATURATION STD ANSI 45

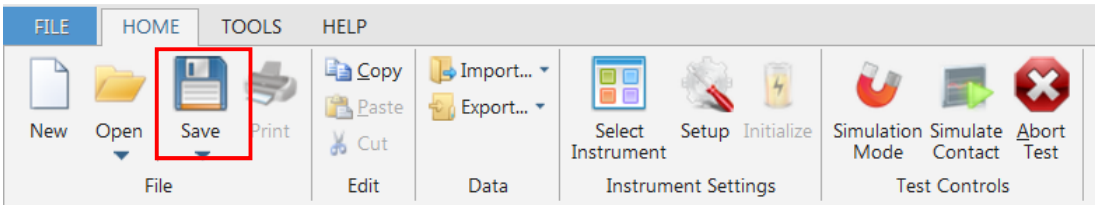
BURDEN VA

Secondary Voltage Injection

	Tap	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
RATIO	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
Phase Dev.		0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
Polarity		Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Knee	Volt.(V)	196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292



Hit the save button to save the file by giving it a file name.



Testing CTs on X0 bushing

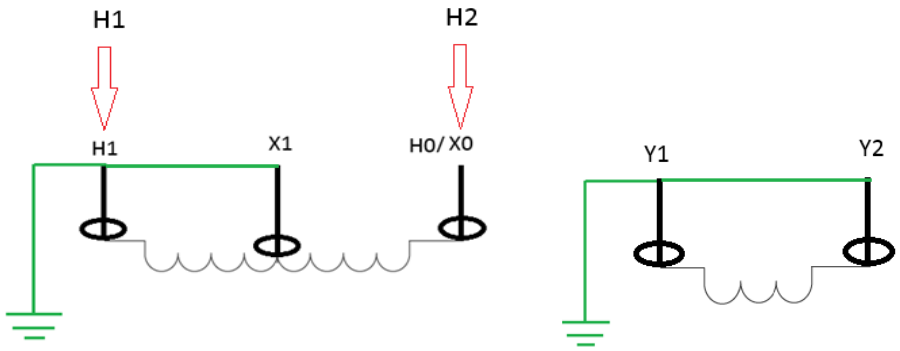
MRCT unit has H and X test leads

a) Connection of H leads

Make following connections for H1 and H2 test leads

Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	H1	Grounded	H2	Grounded	Grounded

Please note that by connecting H1 and H2 test leads as shown above will generate incorrect polarity but that will be taken care of in section below.

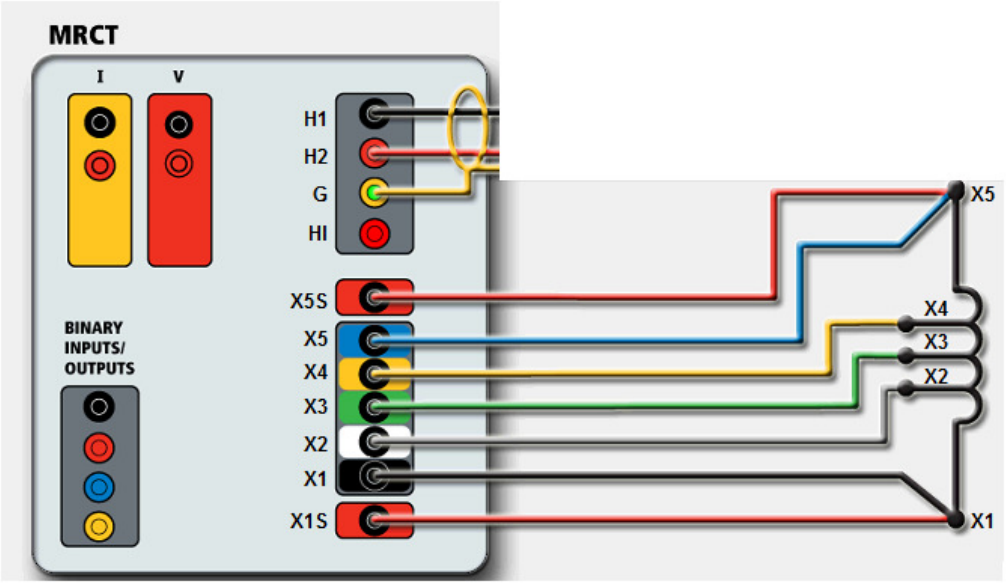


In the nameplate screen check the box "H2 connected to Shroud"

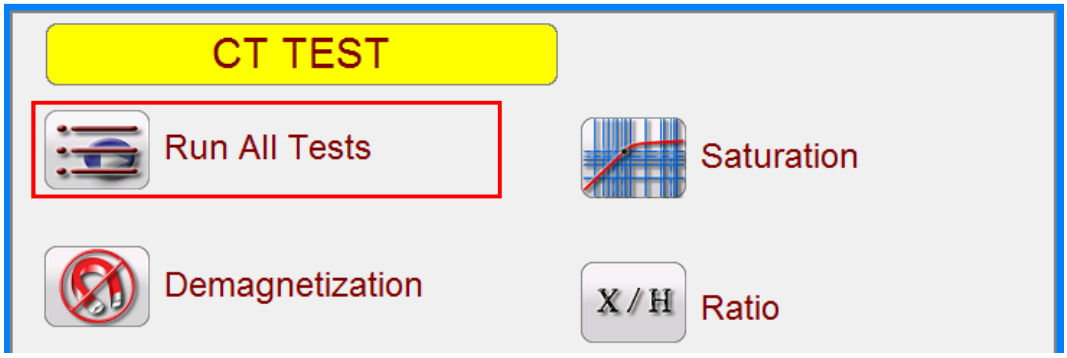
This will take care of incorrect polarity issue.

b) Connection of X leads

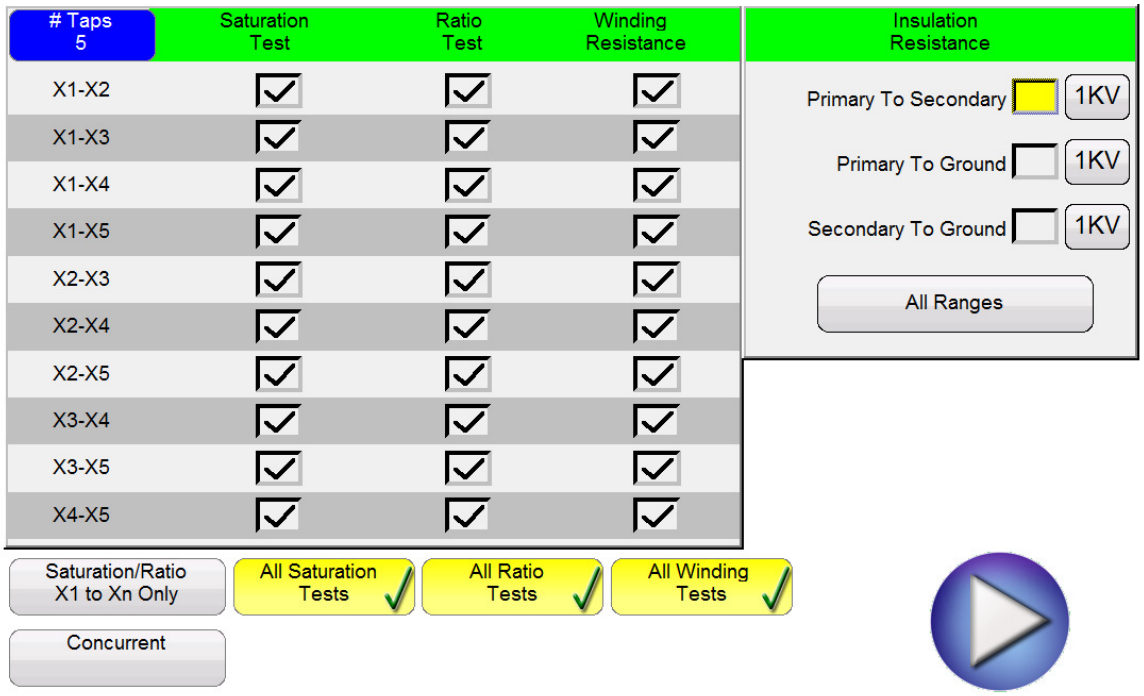
Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the CT under test as per the diagram shown below.



From home screen of the MRCT software select Run All Tests



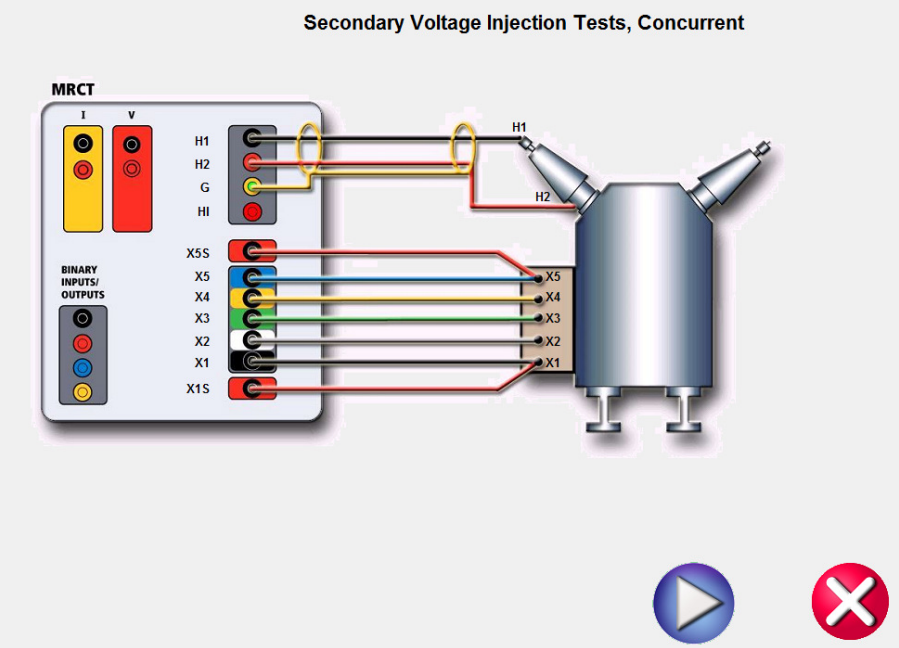
In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

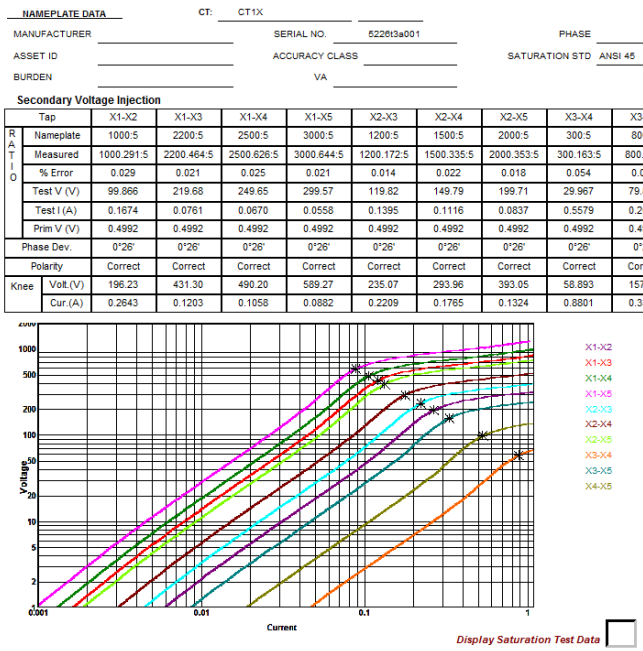
Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:



NAMEPLATE DATA CT: CT1X

MANUFACTURER SERIAL NO. 5226t3a001 PHASE

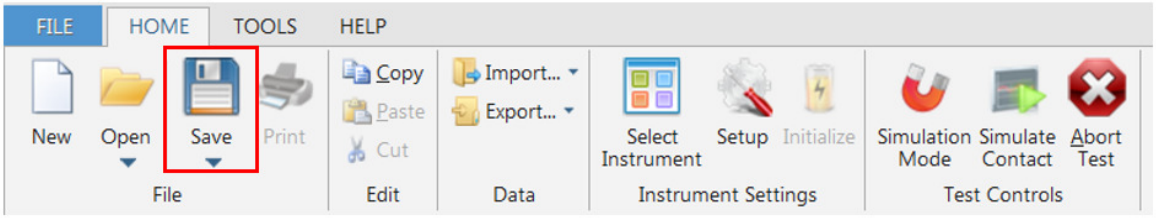
ASSET ID ACCURACY CLASS SATURATION STD ANSI 45

BURDEN VA

Secondary Voltage Injection

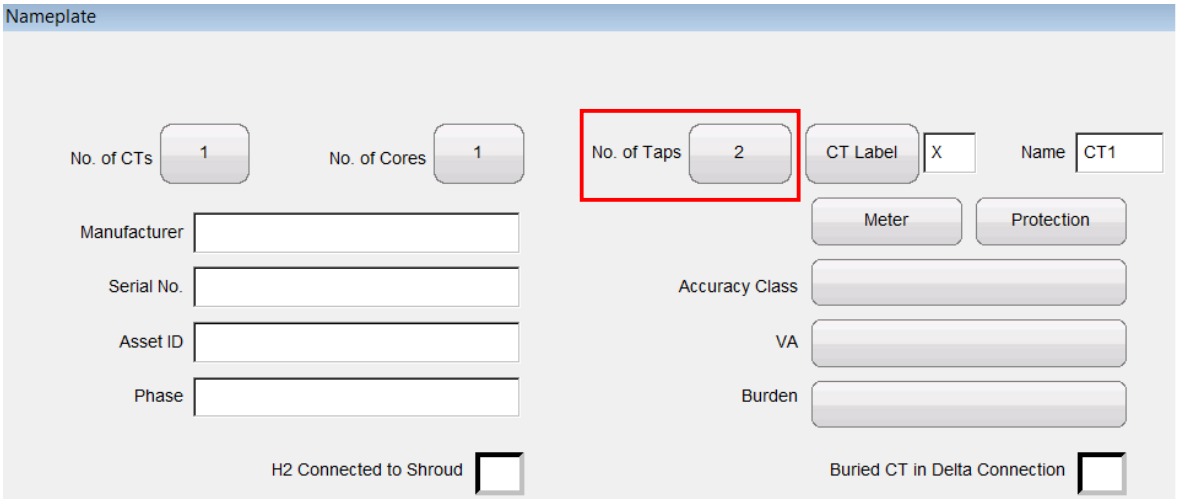
	Tap	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
RATIO	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
Phase Dev.		0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
Polarity		Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Knee	Volt.(V)	196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292

Hit the save button to save the file by giving it a file name.



Testing CTs on Y1 bushing

If the tertiary winding has only single tap, user can change the no. of taps to two by going to nameplate screen:

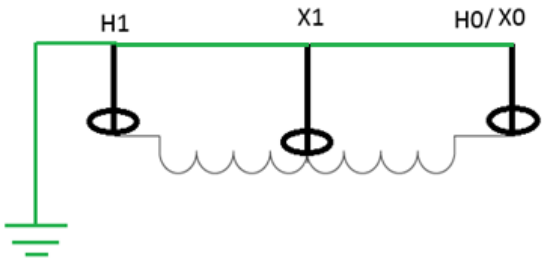


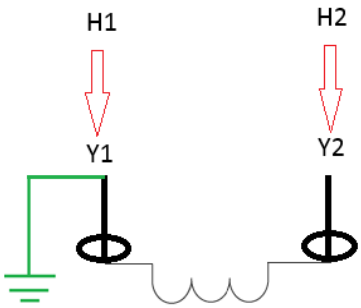
MRCT unit has H and X test leads

a) Connection of H leads

Make following connections for H1 and H2 test leads

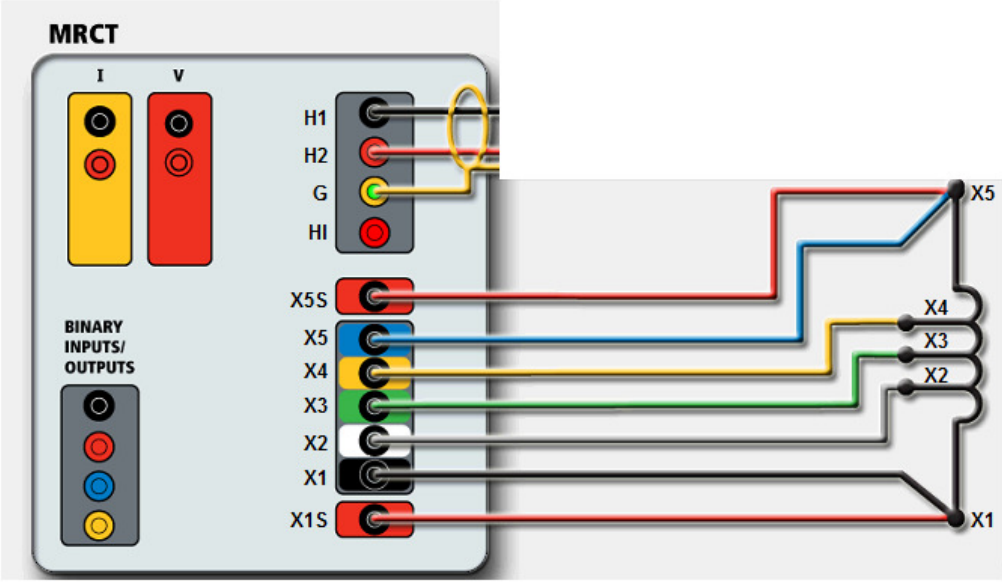
Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	Grounded	Grounded	Grounded	H1 and Grounded	H2



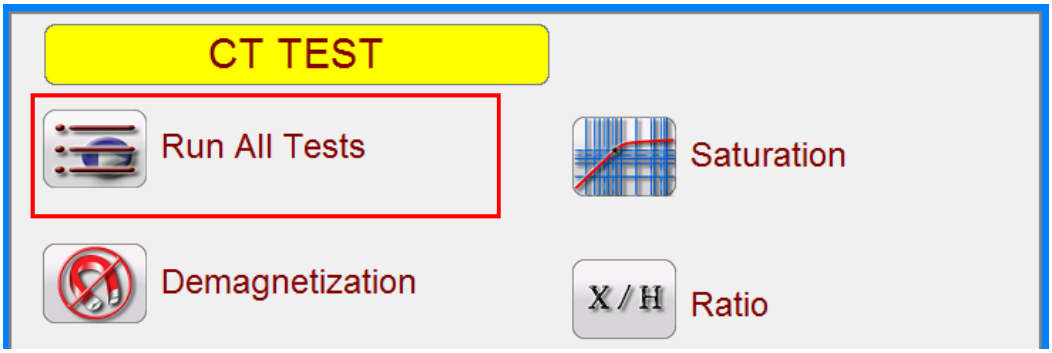


b) Connection of X leads

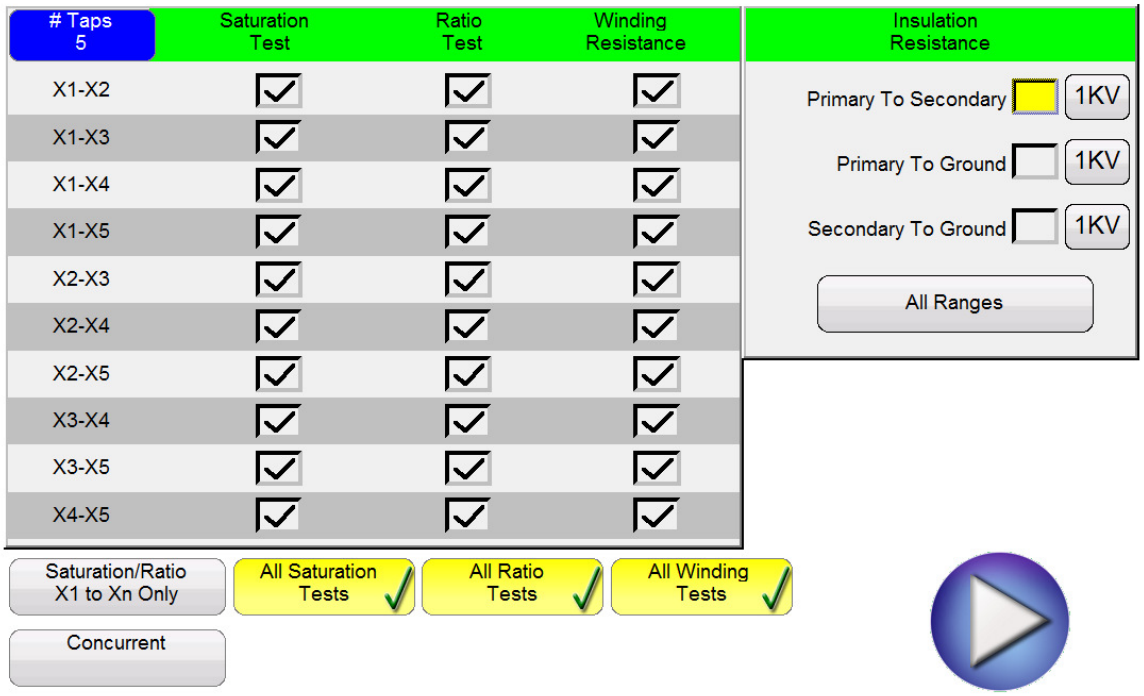
Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the CT under test as per the diagram shown below.



From home screen of the MRCT software select Run All Tests



In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

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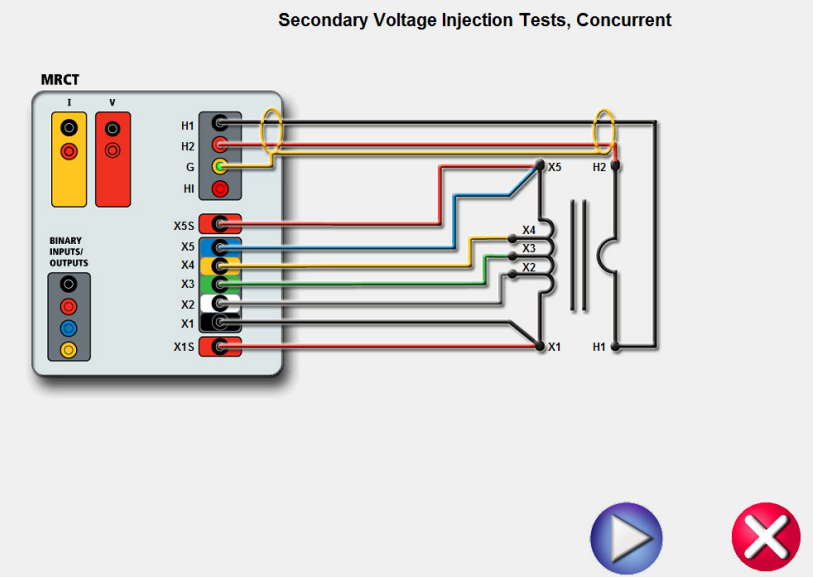

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- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:

NAMEPLATE DATA CT: CT1X

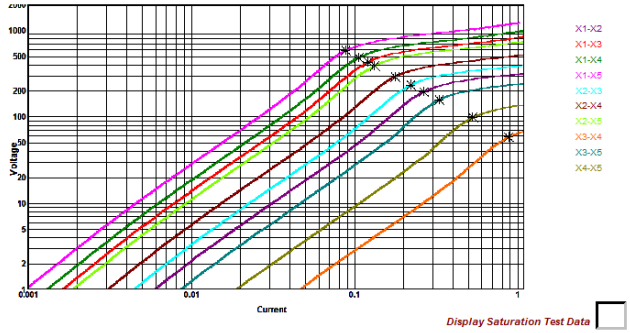
MANUFACTURER SERIAL NO. 5226t3a001 PHASE

ASSET ID ACCURACY CLASS SATURATION STD ANSI 45

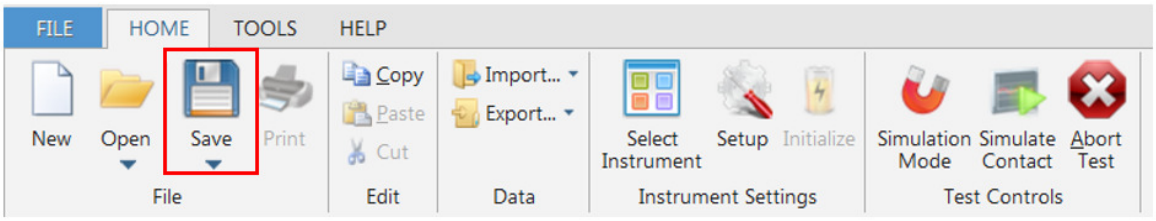
BURDEN VA

Secondary Voltage Injection

	Tap	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
RATIO	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
Phase Dev.		0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
Polarity		Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Knee	Volt.(V)	196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292

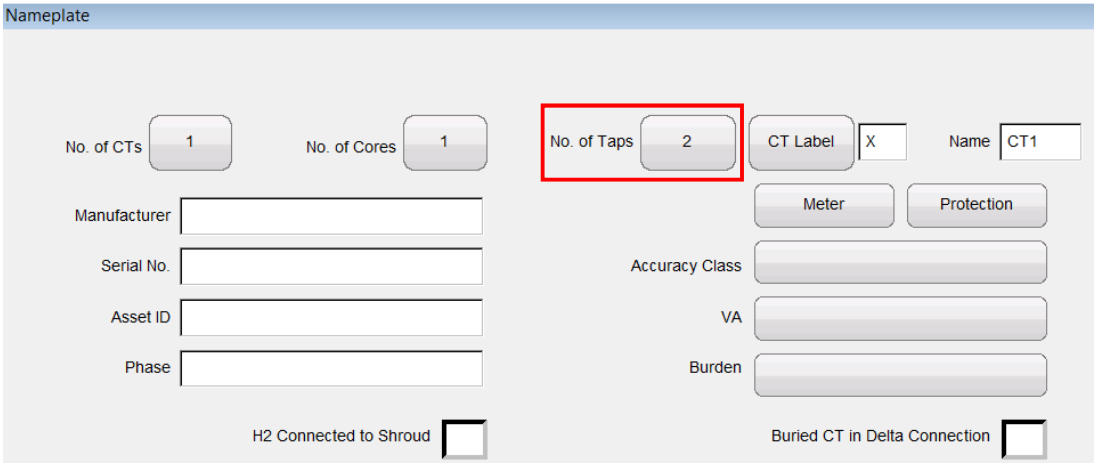


Hit the save button to save the file by giving it a file name.



Testing CTs on Y2 bushing

If the tertiary winding has only single tap, you can change the no. of taps to 2 by going to nameplate screen:

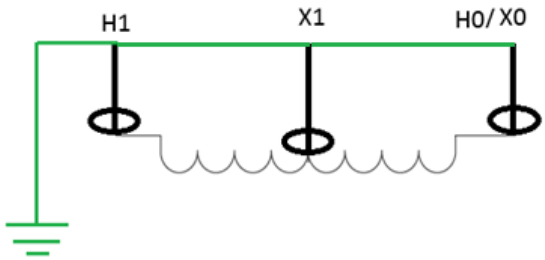


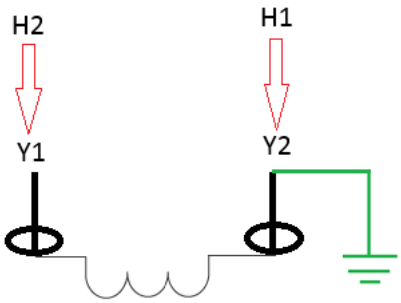
MRCT unit has H and X test leads

a) Connection of H leads

Make following connections for H1 and H2 test leads

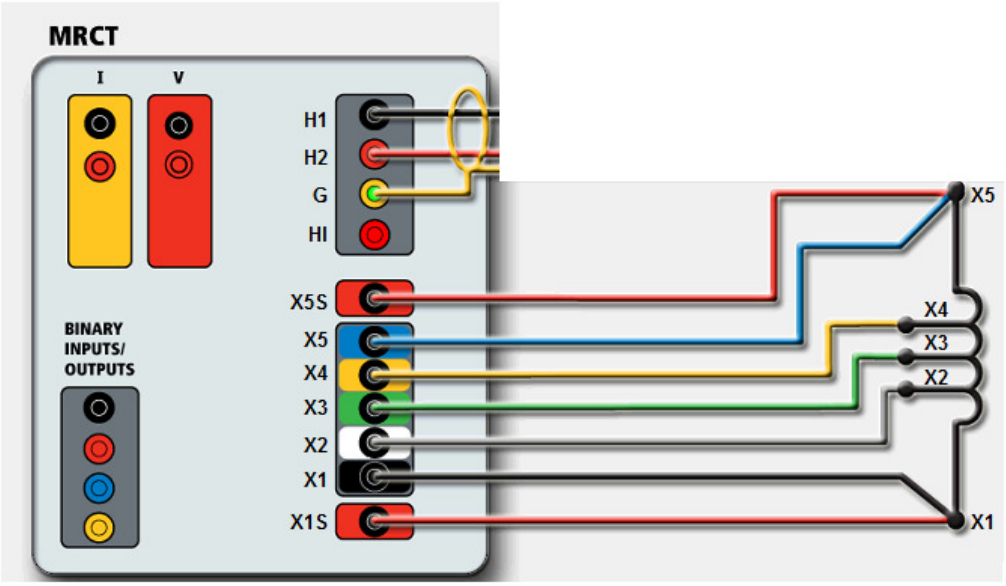
Bushing	H1	X1	H0- Xo	Y1	Y2
MRCT leads	Grounded	Grounded	Grounded	H2	H1 and Grounded



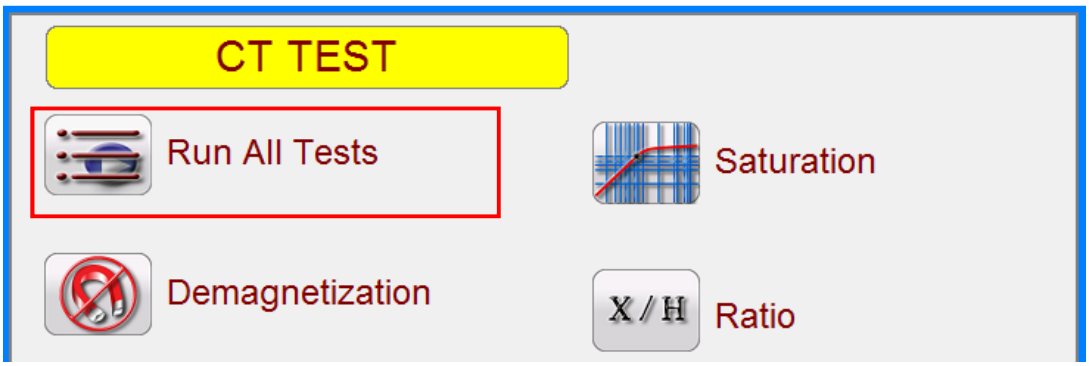


b) Connection of X leads

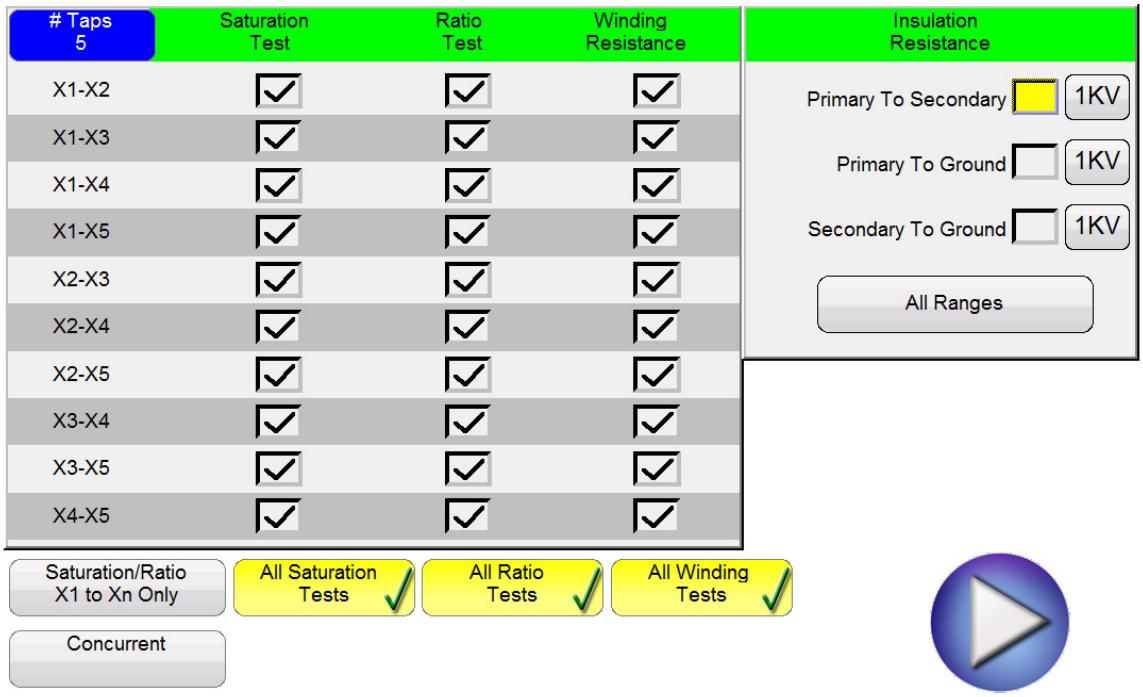
Connect MRCT secondary leads marked X1S, X1, X2, X3, X4, X5 and X5S to the secondary of the CT under test as per the diagram shown below.



From home screen of the MRCT software select Run All Tests



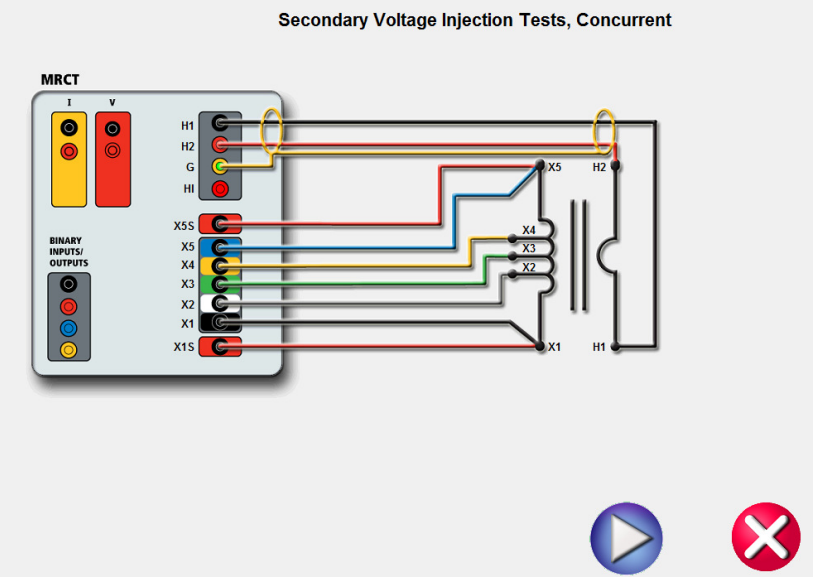
In the Test selection screen, check all saturation, all ratio and all winding resistance test. Ratio test includes polarity test.



It is important to NOT check insulation resistance test as high side is intentionally shorted to ground to eliminate the interference. User would have to perform the insulation resistance separately.

Hit the play button to run the test

Following diagram will show up. Hit the play button again to confirm and unit will initiate the test.



The tests will be performed in following order:

- DC winding resistance of CT secondary
- Demagnetization
- Saturation or Excitation Test
- Ratio and Polarity test

At the end of the test, a report similar to below will show up:

NAMEPLATE DATA CT: CT1X

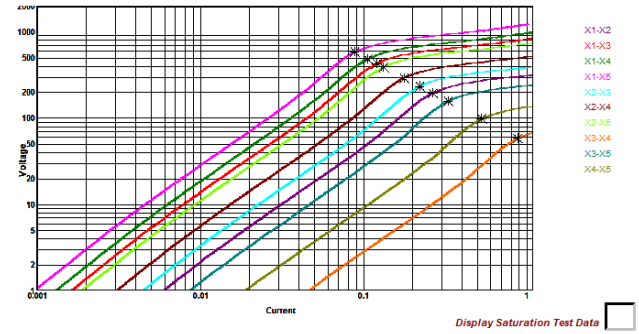
MANUFACTURER SERIAL NO. 5226t3a001 PHASE

ASSET ID ACCURACY CLASS SATURATION STD ANSI 45

BURDEN VA

Secondary Voltage Injection

	Tap	X1-X2	X1-X3	X1-X4	X1-X5	X2-X3	X2-X4	X2-X5	X3-X4	X3-X5	X4-X5
RATIO	Nameplate	1000:5	2200:5	2500:5	3000:5	1200:5	1500:5	2000:5	300:5	800:5	500:5
	Measured	1000.291:5	2200.464:5	2500.626:5	3000.644:5	1200.172:5	1500.335:5	2000.353:5	300.163:5	800.18:5	500.018:5
	% Error	0.029	0.021	0.025	0.021	0.014	0.022	0.018	0.054	0.023	0.004
	Test V (V)	99.866	219.68	249.65	299.57	119.82	149.79	199.71	29.967	79.888	49.920
	Test I (A)	0.1674	0.0761	0.0670	0.0558	0.1395	0.1116	0.0837	0.5579	0.2093	0.3349
	Prim V (V)	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992	0.4992
Phase Dev.		0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'	0°26'
Polarity		Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
Knee	Volt.(V)	196.23	431.30	490.20	589.27	235.07	293.96	393.05	58.893	157.93	99.016
	Cur.(A)	0.2643	0.1203	0.1058	0.0882	0.2209	0.1765	0.1324	0.8801	0.3306	0.5292



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